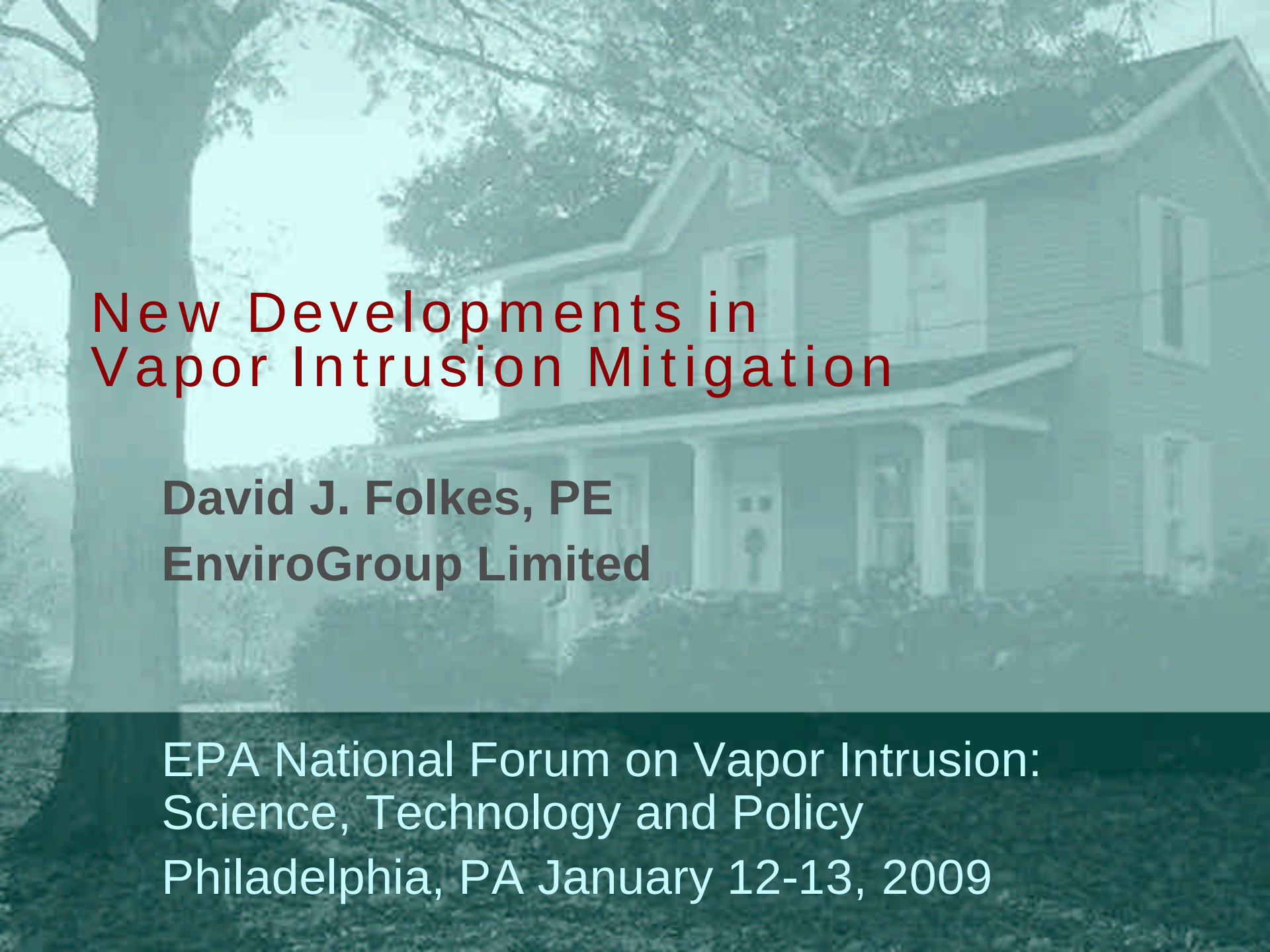


New Developments in Vapor Intrusion Mitigation

David J. Folkes, PE

EnviroGroup Limited

EPA National Forum on Vapor Intrusion: Science, Technology and Policy

Philadelphia, PA January 12-13, 2009

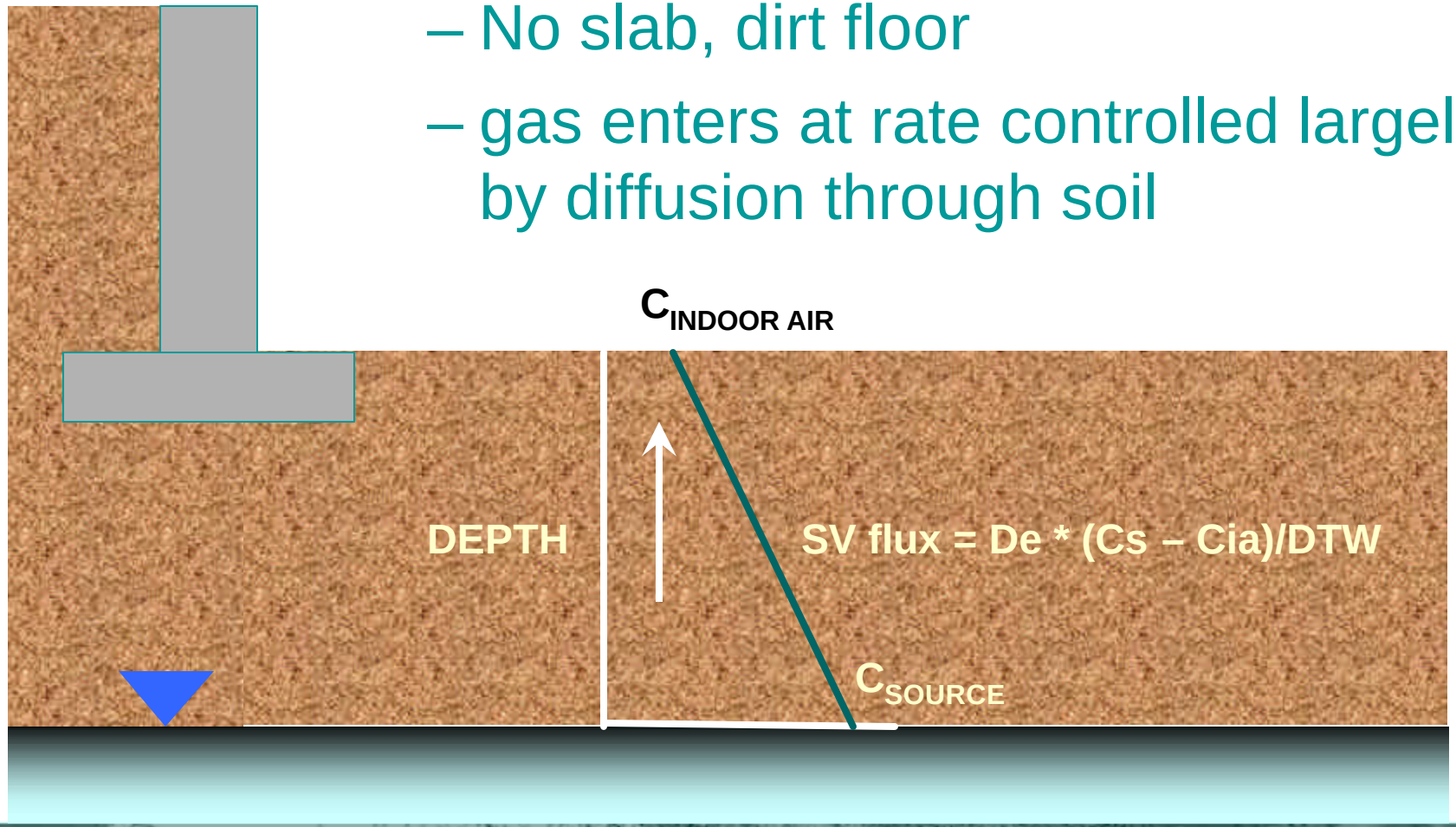
Outline

- Mitigation concepts
- New Developments
  - Barriers
  - Venting
  - Depressurization
  - Sustainable systems

No specific product endorsements are intended by this presentation.

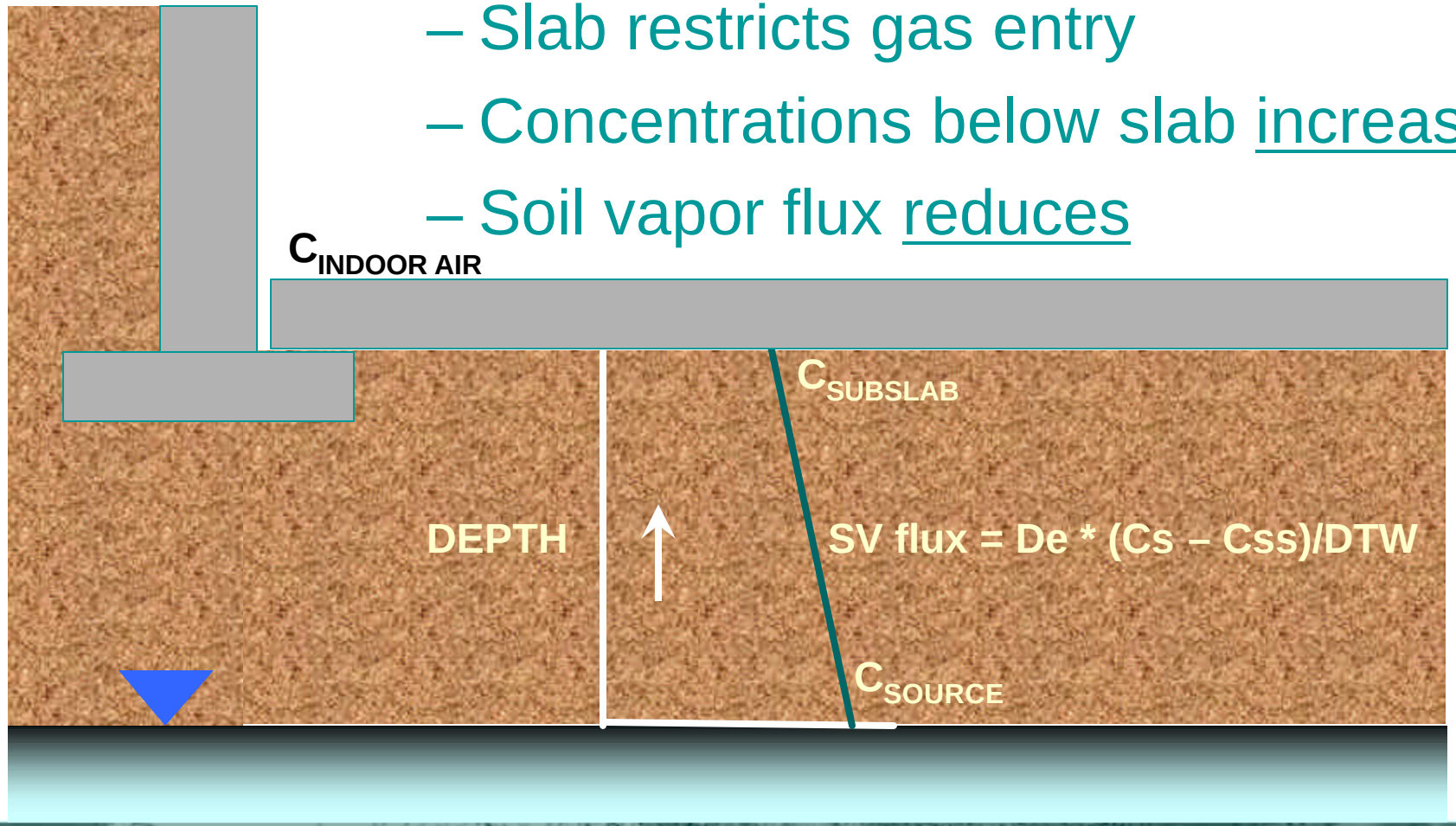
Mitigation Concepts

- No slab, dirt floor
- gas enters at rate controlled largely by diffusion through soil



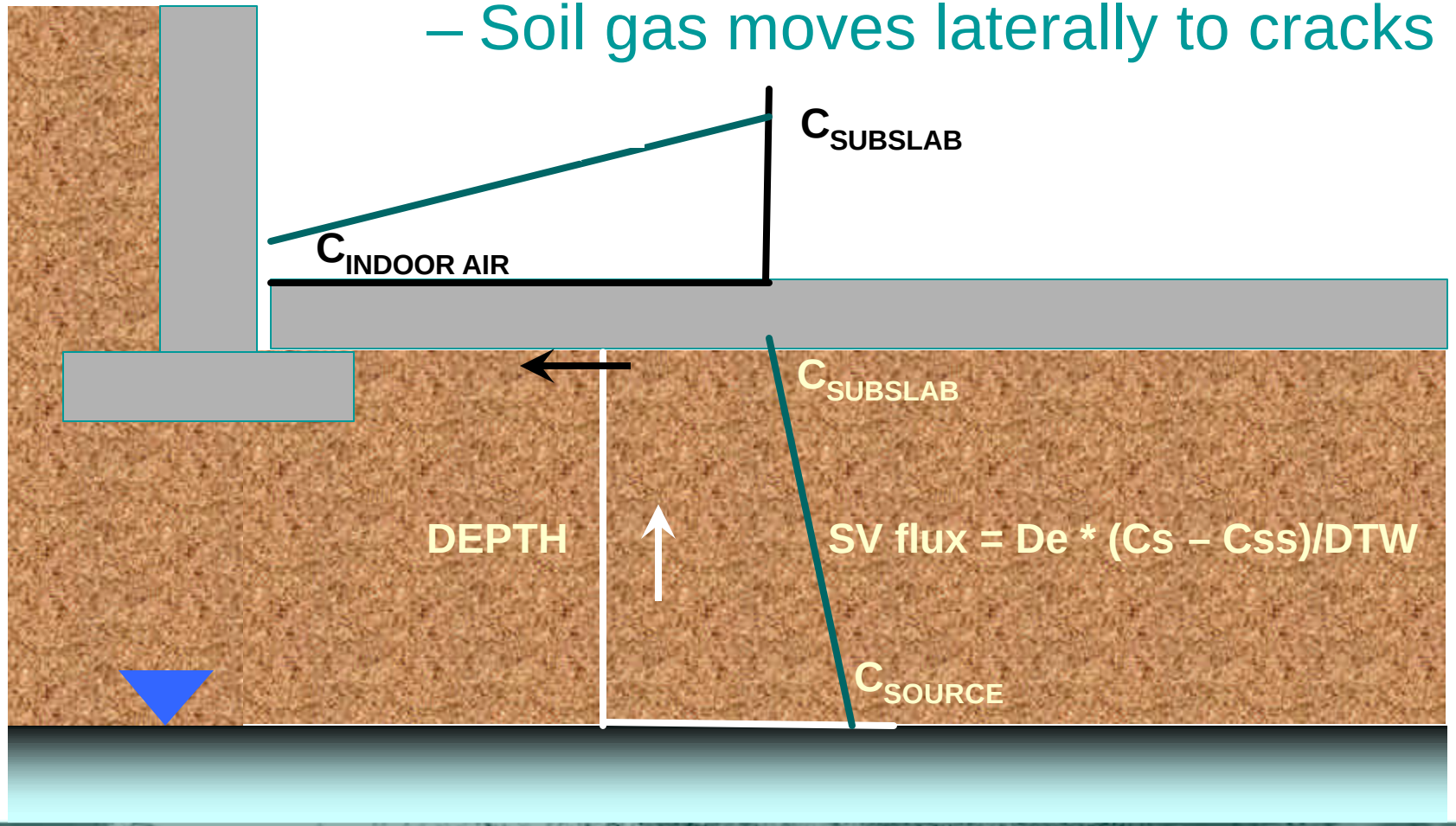
Mitigation Concepts

- Slab restricts gas entry
- Concentrations below slab increase
- Soil vapor flux reduces



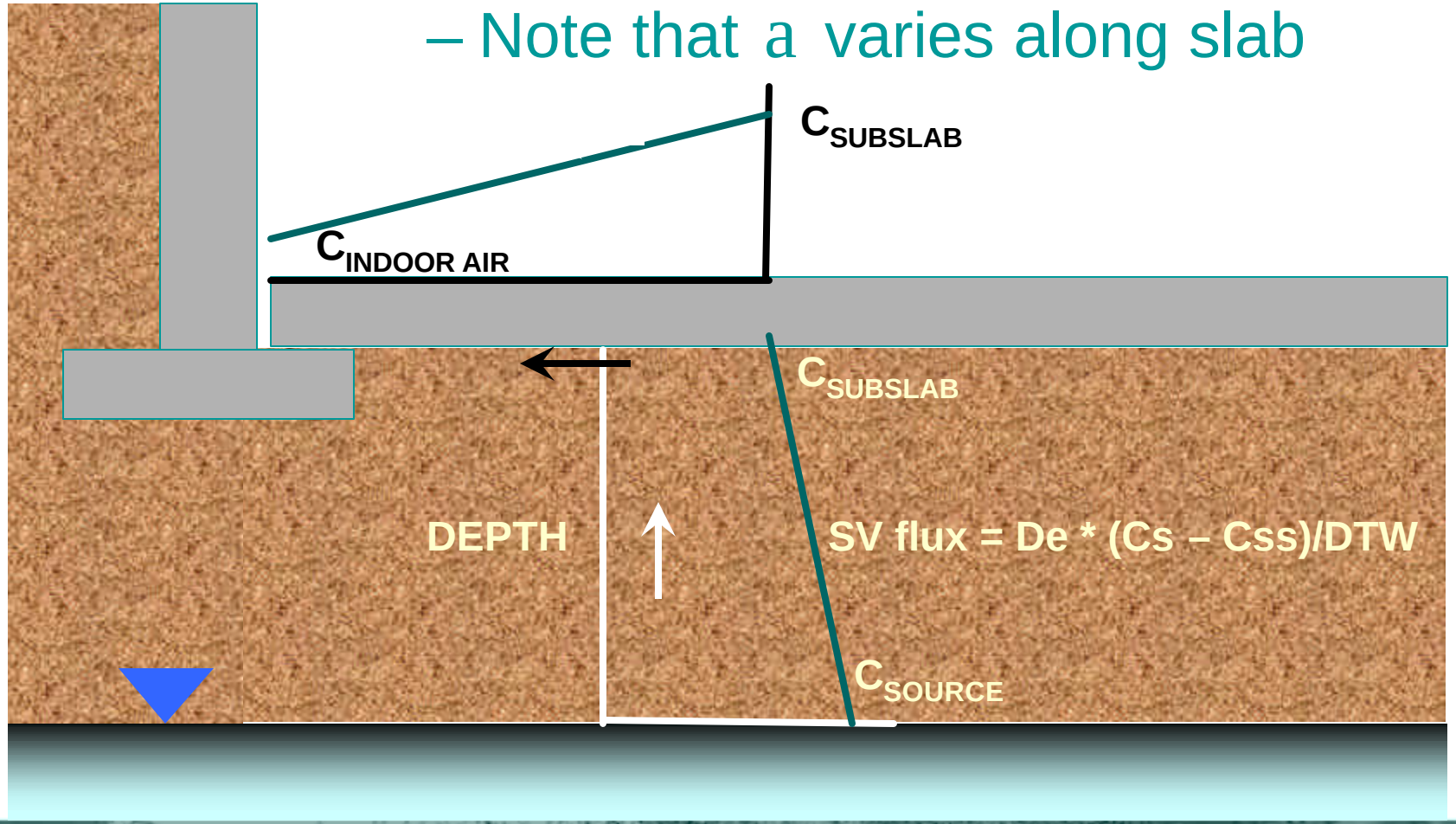
Mitigation Concepts

– Soil gas moves laterally to cracks



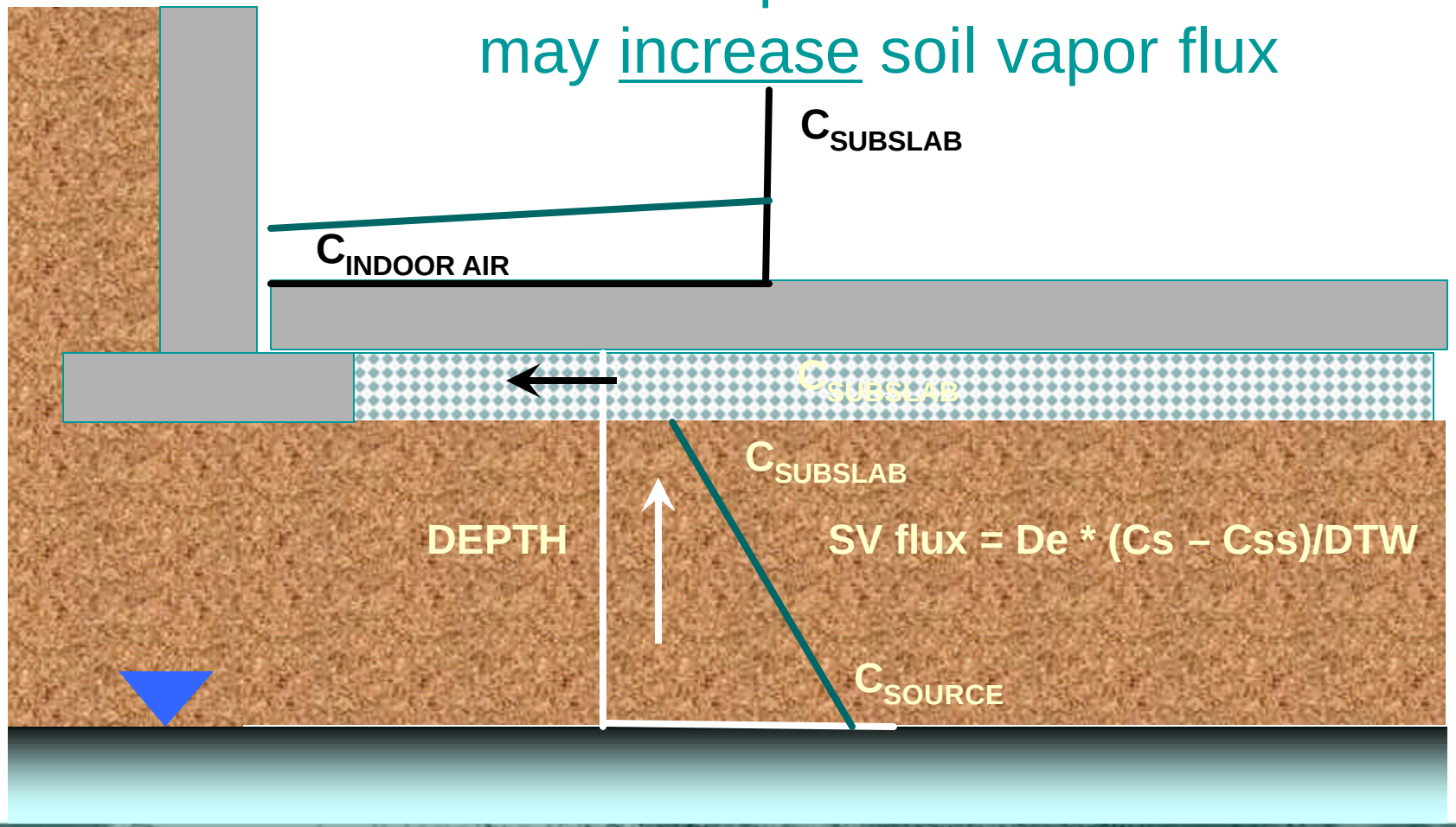
Mitigation Concepts

– Note that a varies along slab



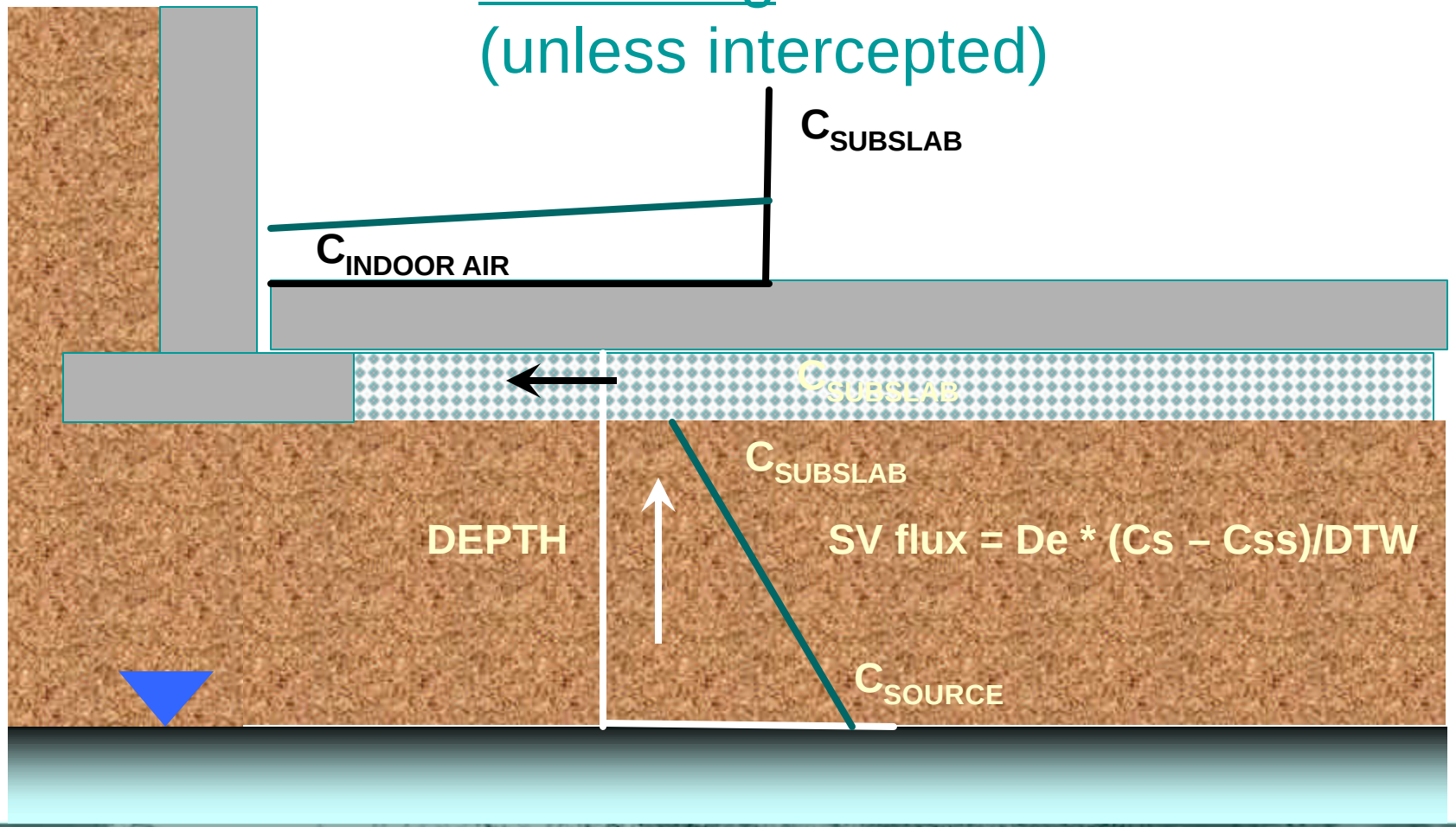
Mitigation Concepts

– Note that permeable base course may increase soil vapor flux



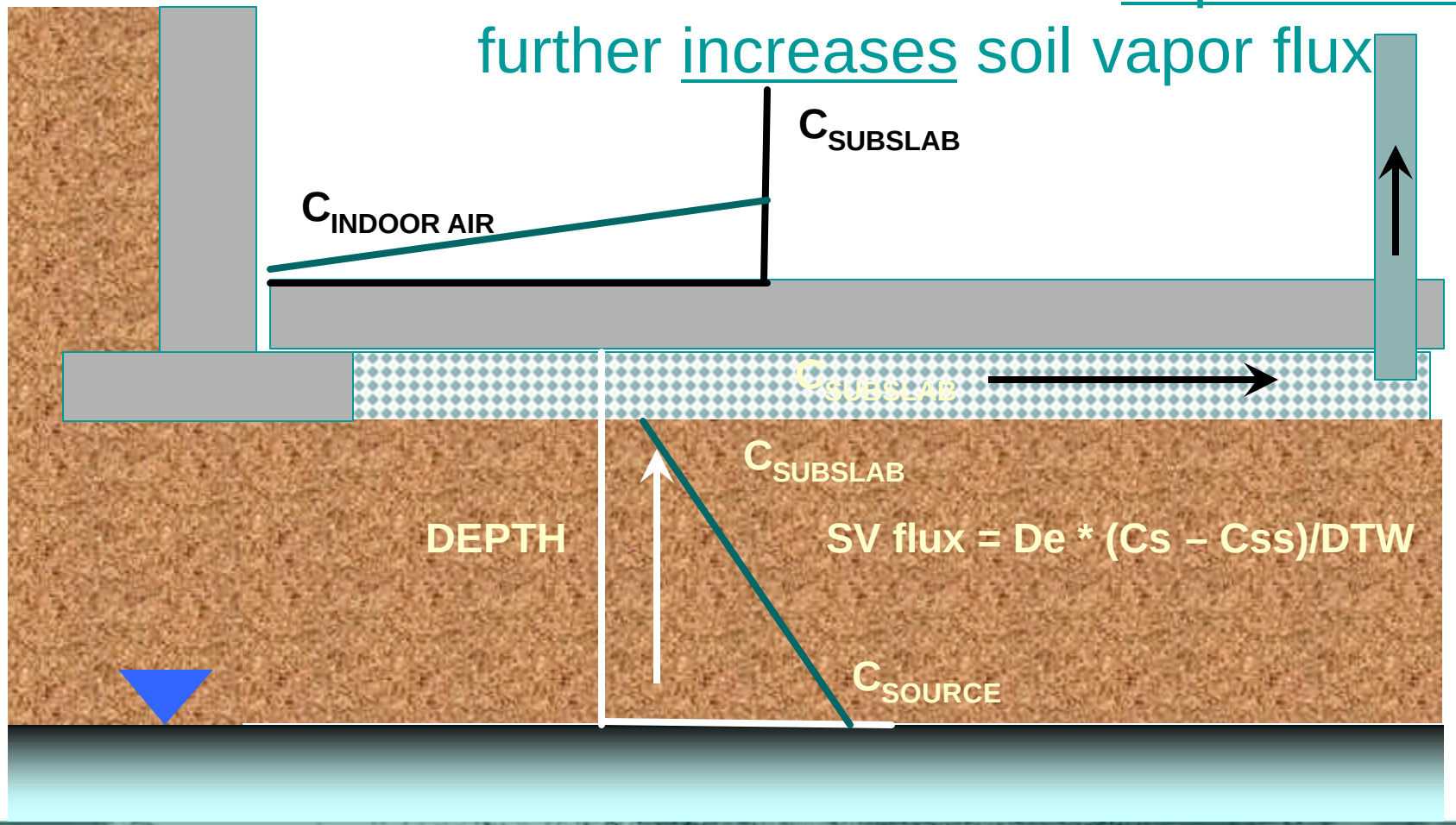
Mitigation Concepts

– Increasing indoor air concentration (unless intercepted)



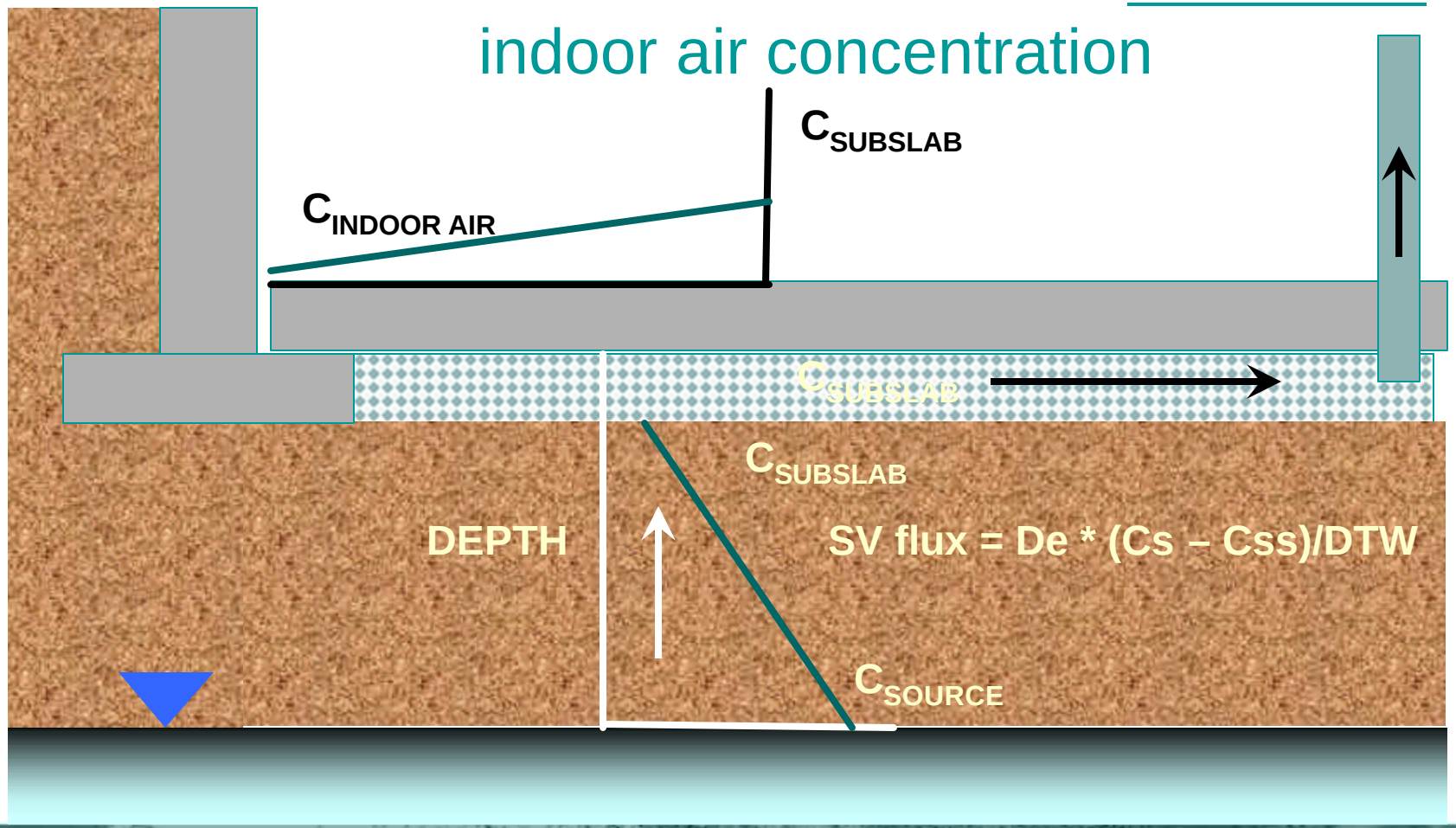
Mitigation Concepts

– Use of base course to depressurize further increases soil vapor flux



Mitigation Concepts

– But downward air flow <u>decreases</u> indoor air concentration



Key Mitigation Points

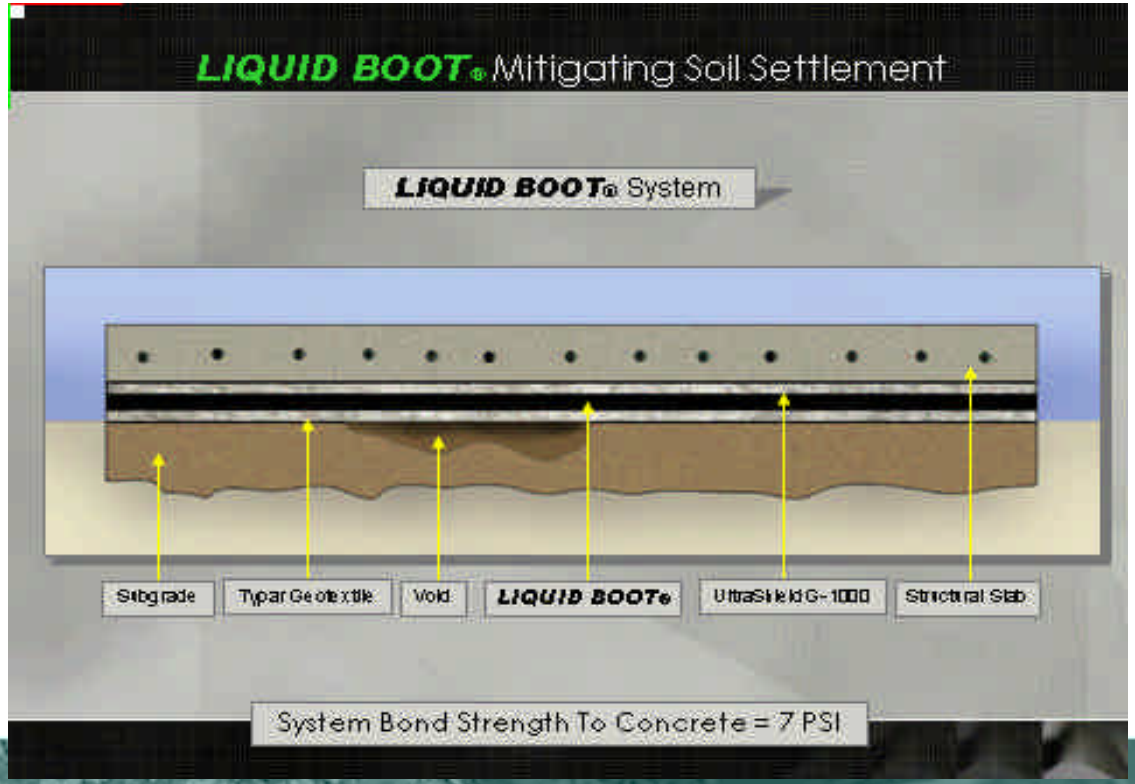
- Understand how the subsurface will respond to mitigation features
- Understand the difference between barriers, venting, and depressurization
- Do it well

Barrier Concepts

- Concentrations build up below barrier
  - Concentration gradient flatter
  - Diffusion flux slower
  - Vapors diffuse laterally
- Key concepts
  - Barrier thickness/integrity
  - Composite barriers enhance performance
  - Venting layers may decrease performance unless well ventilated or depressurized

New Developments - Barriers

- Thick (e.g. 60 mil) asphaltic spray-on barriers have been available for many years

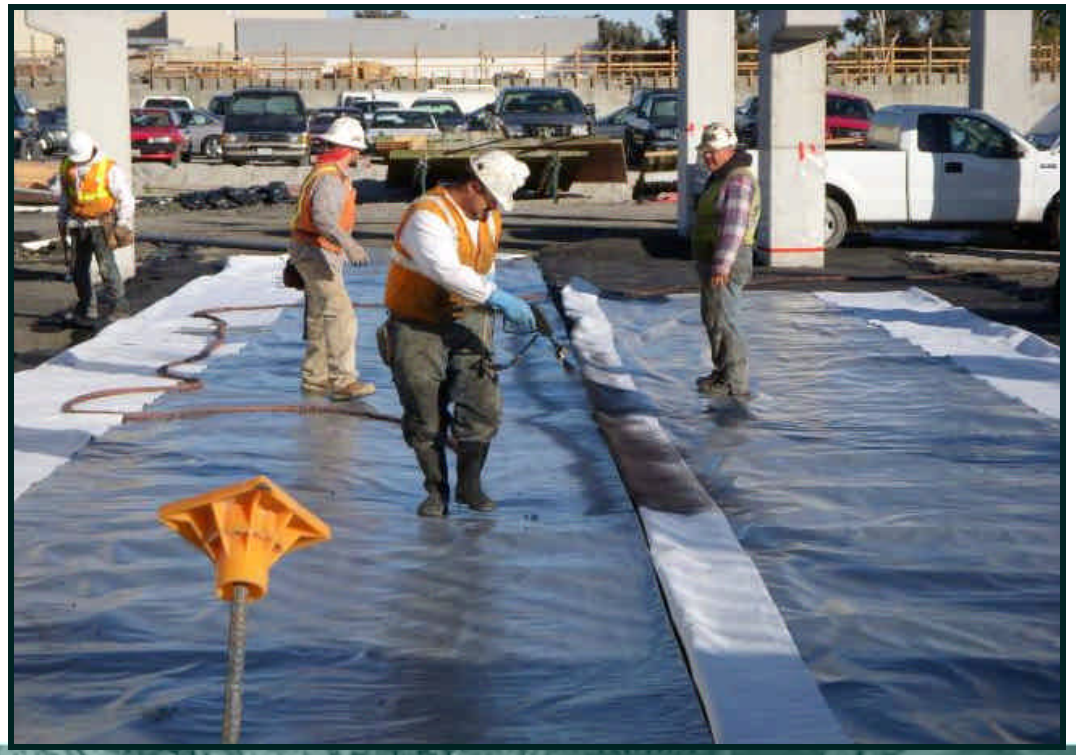


Courtesy Liquid Boot®

New Developments - Barriers

- New barrier products include an HDPE and spray-on asphalt

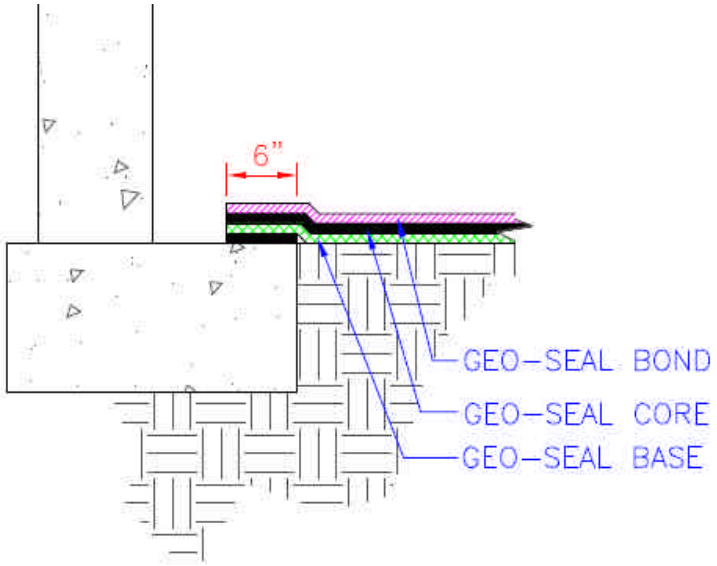
Geo-Seal™



Provided courtesy of Land Science Technologies

New Developments - Barriers

- Composite spray-on barrier (Geo-Seal)
  - HDPE provides chemical resistance
  - 15 mil HDPE above & below asphalt core
  - Asphalt core allows thinner, flexible HDPE
  - Breaches in membrane “sealed” by asphalt



Geo-Seal™

Courtesy Land Science Technologies

Venting Concepts

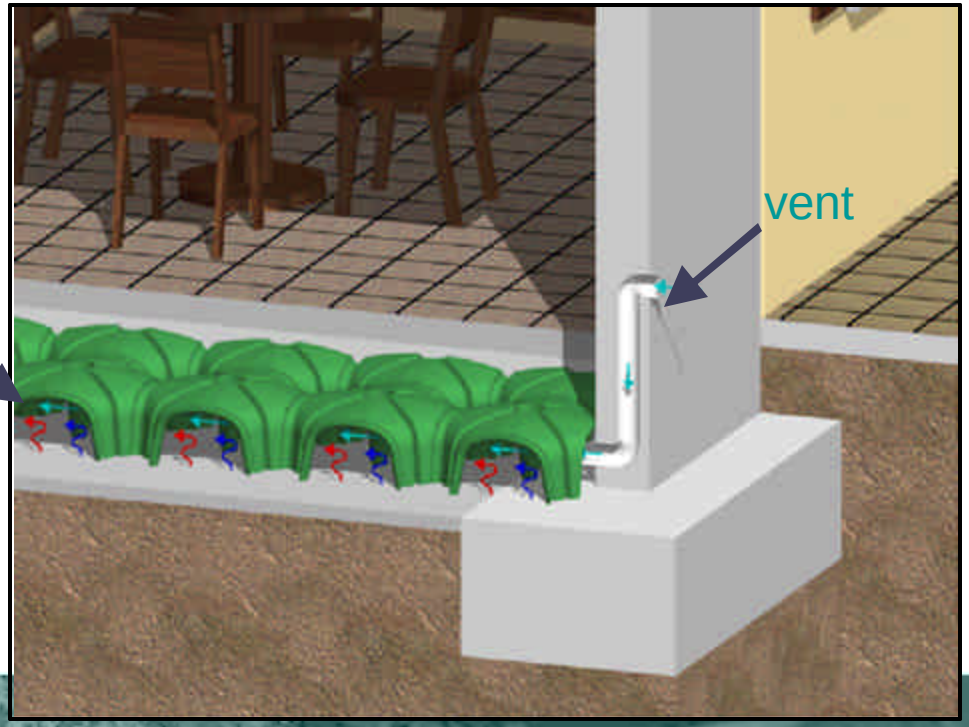
- Air movement through venting layer dilutes concentrations below slab
- Venting layer is not necessarily depressurized
  - Stack effect can still pull sub-slab vapors into building
- Venting relies on sufficient dilution to reduce sub-slab concentrations
- Generally applicable when vapor concentrations only modestly elevated
- Venting efficiency/rate is the key

New Developments in Venting*New to U.S.

- Aerated floor systems
  - Allow highly efficient movement of air through voids in slab

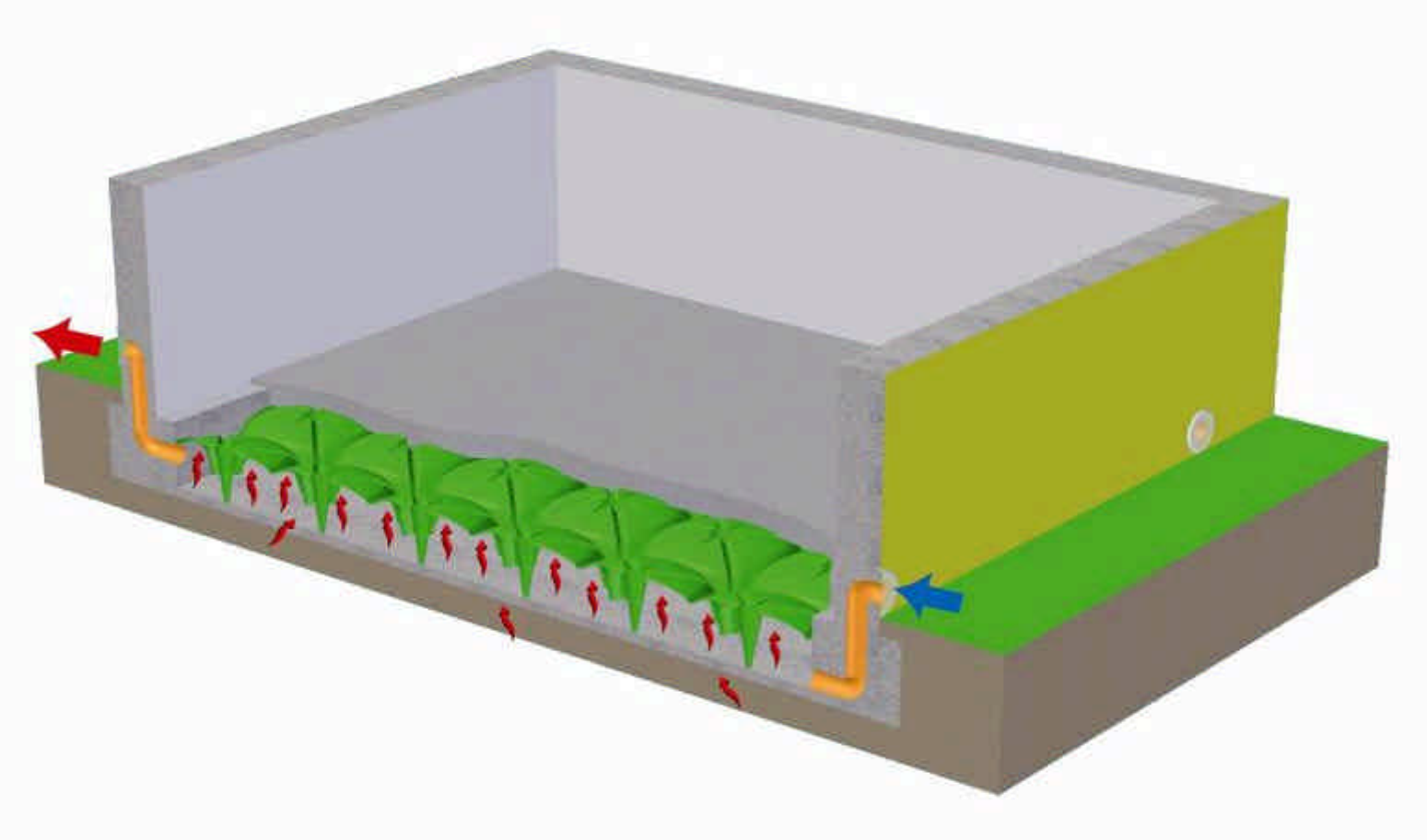
CUPOLEX® BUILDING SYSTEMS

Dome-shaped polypropylene forms below concrete create inter-connected void system



Courtesy Pontarolo Engineering

Cupolex ® Aerated Floor System



Courtesy Pontarolo Engineering

Cupolex ® Aerated Floor System

- Aerated floor systems

CUPOLEX ® forms and vent pipes in place prior to pouring concrete slab.

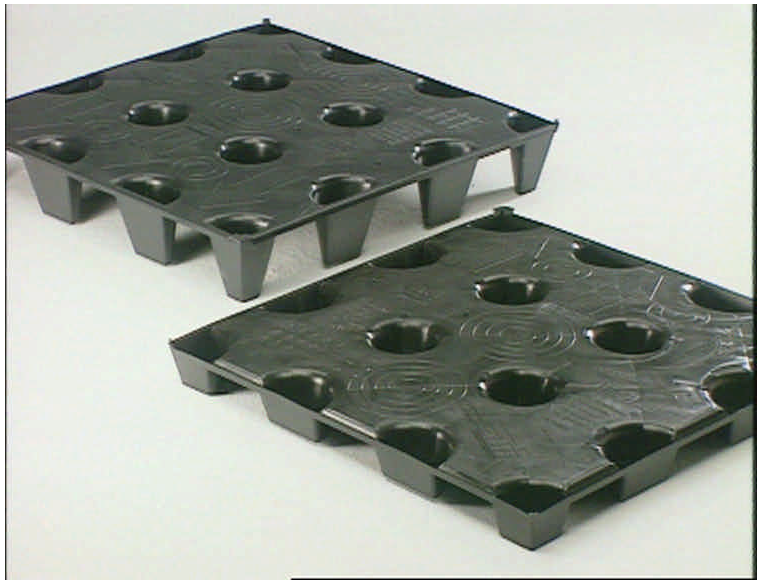
Separations in forms create grade beams in slab.

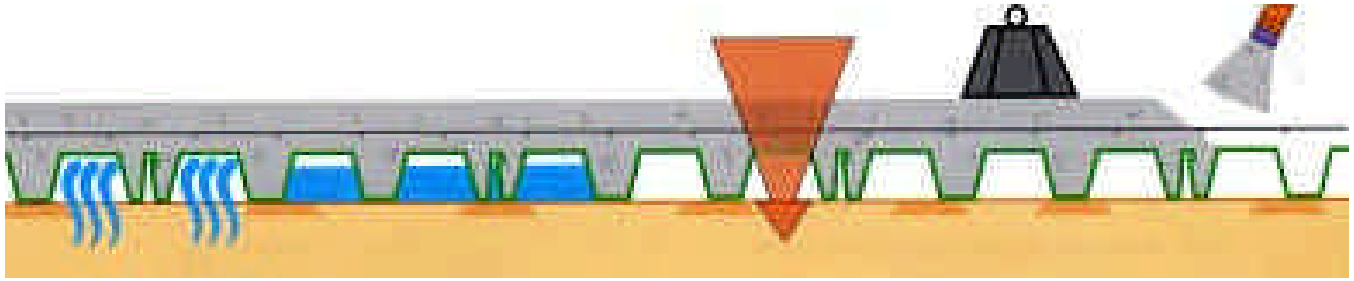
Courtesy Pontarolo Engineering

Aerated Floors on Existing Floors

Cupolex Windi®

- Aerated floor sub-base
- Concrete poured on top of forms
- Void space vented
- Can be attached to walls





Venting of Aerated Floors

- Air moves through voids more efficiently than gravel

From Ove Arup, Sept 1997

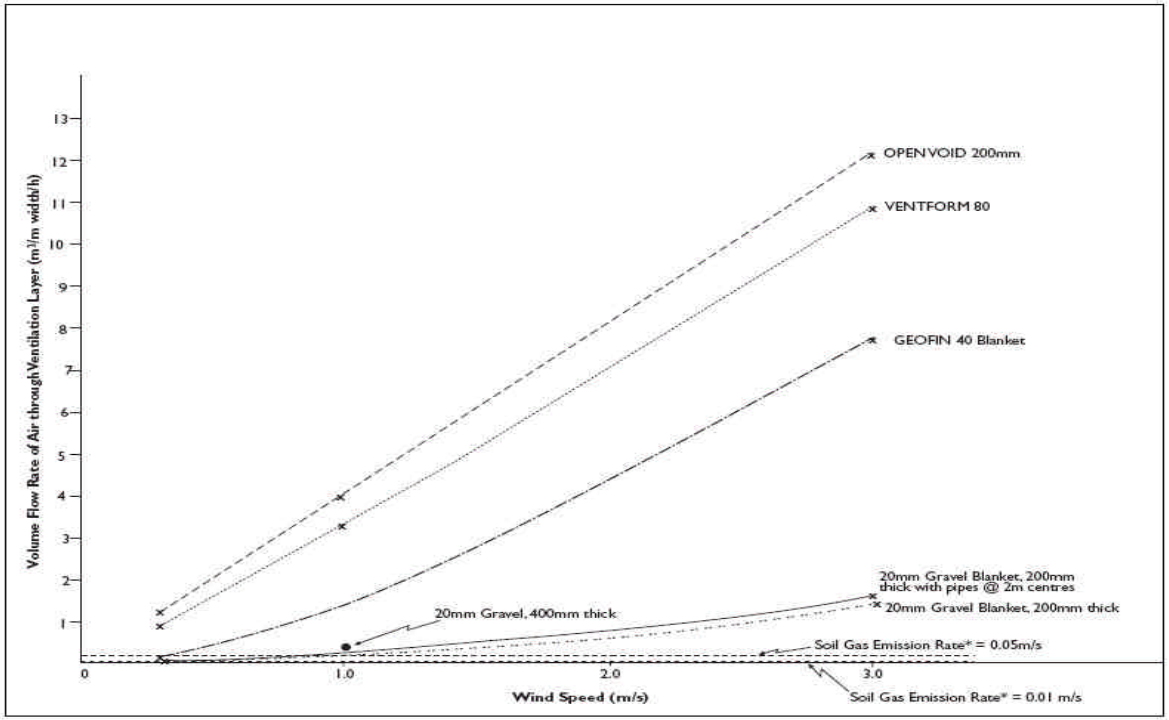
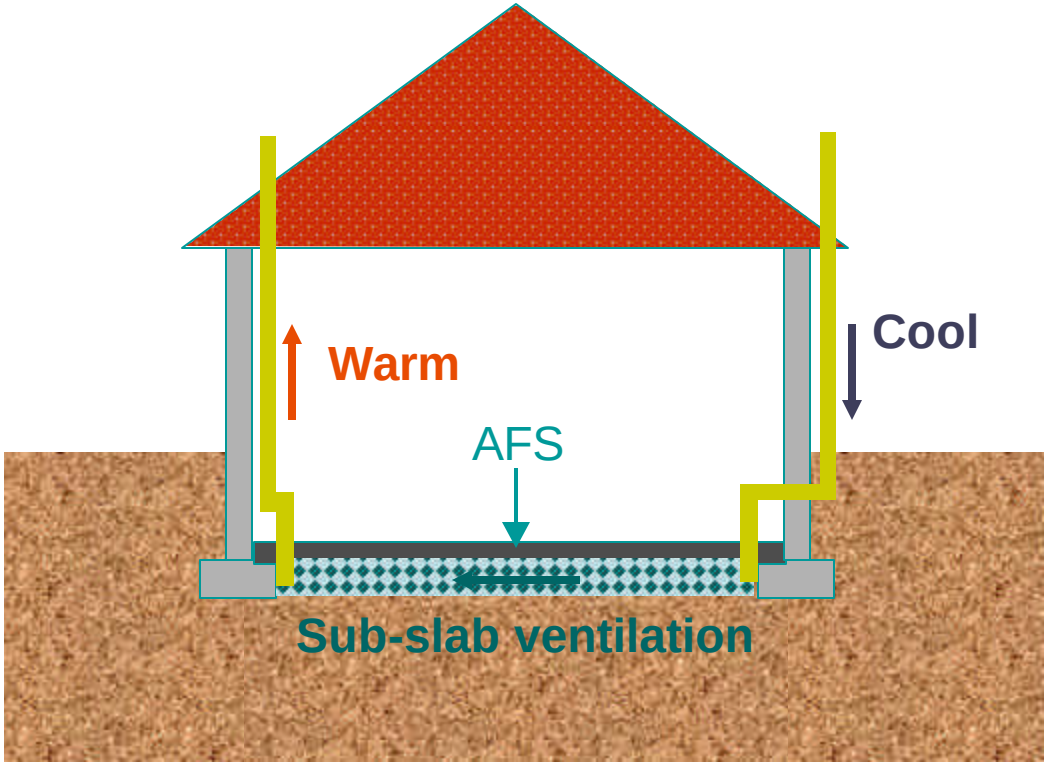


Figure 4
Result of CFD Modelling: Volume Flow Rate vs Wind Speed for 5m x 5m Foundation

Passive Venting of Aerated Floors

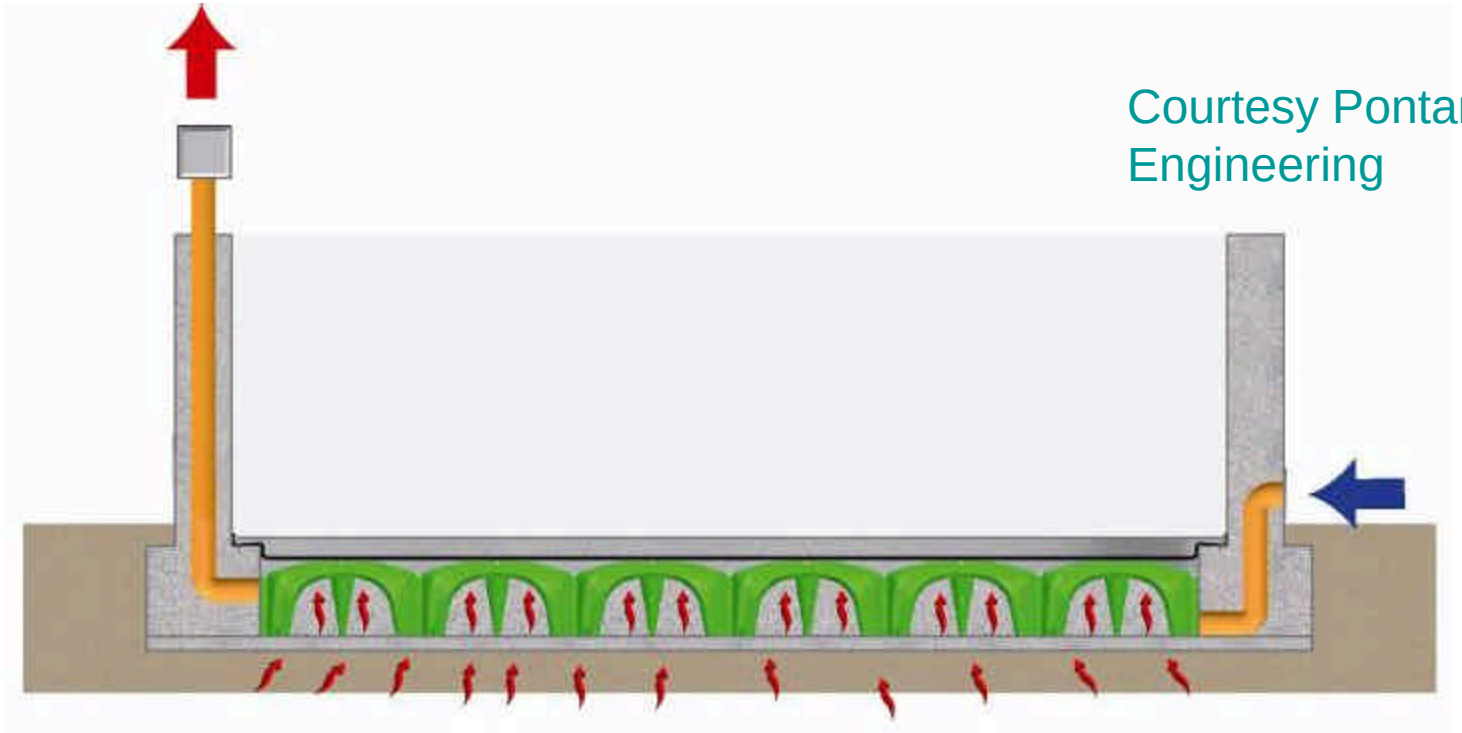
- Thermal gradients



Air flow direction reverses in summer

Cupolex ® Passive Venting Design

- Thermal gradients

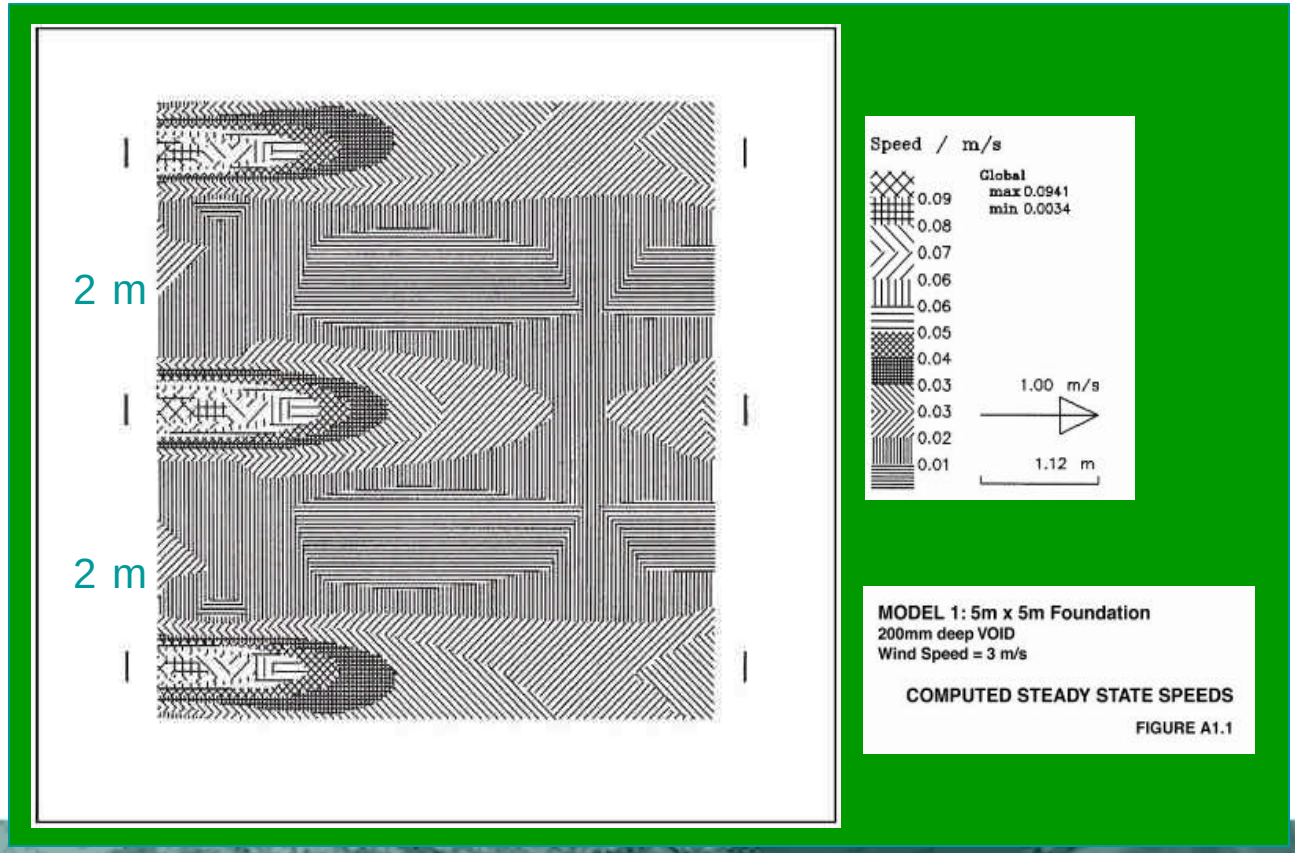


Courtesy Pontarolo Engineering

Direct air flow through AFS

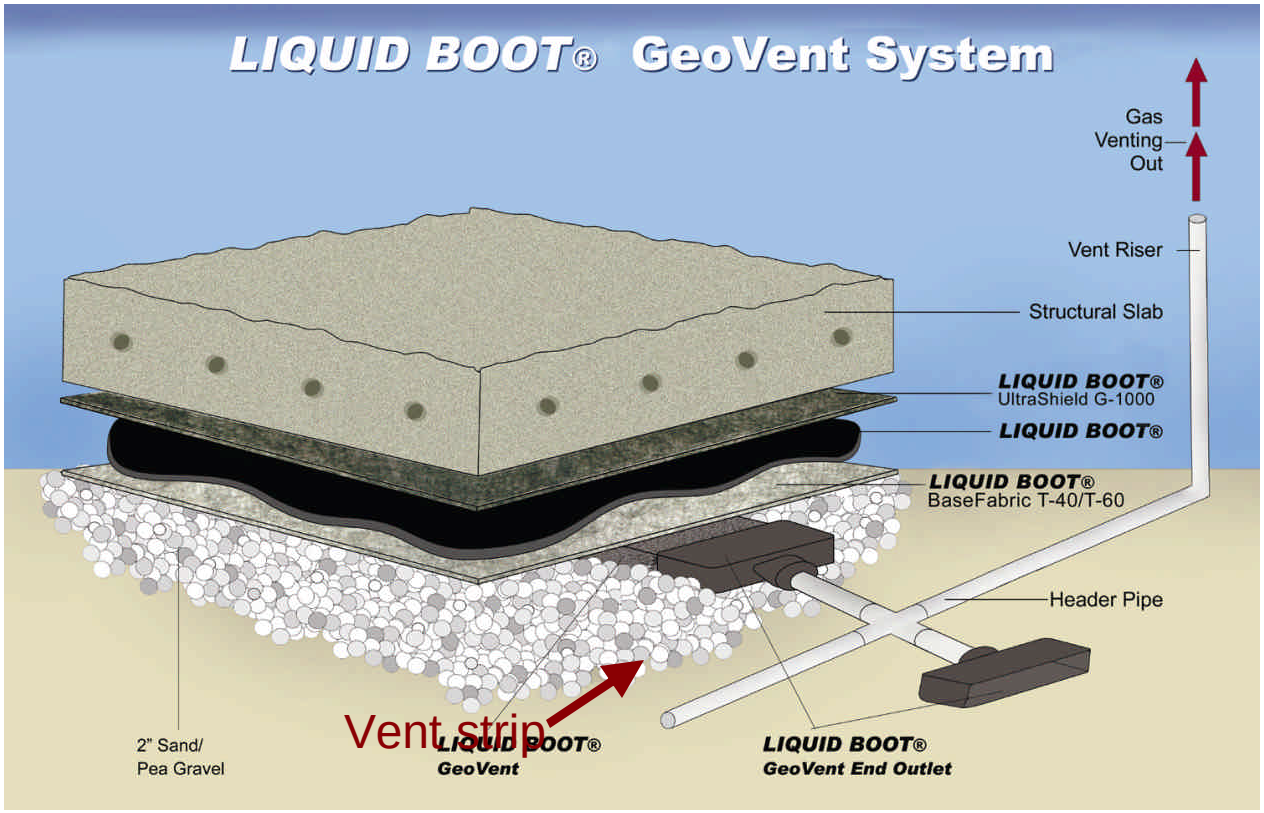
- Results of modeling study by Ove Arup 1997

Courtesy Pontarolo Engineering



Geosynthetic venting media

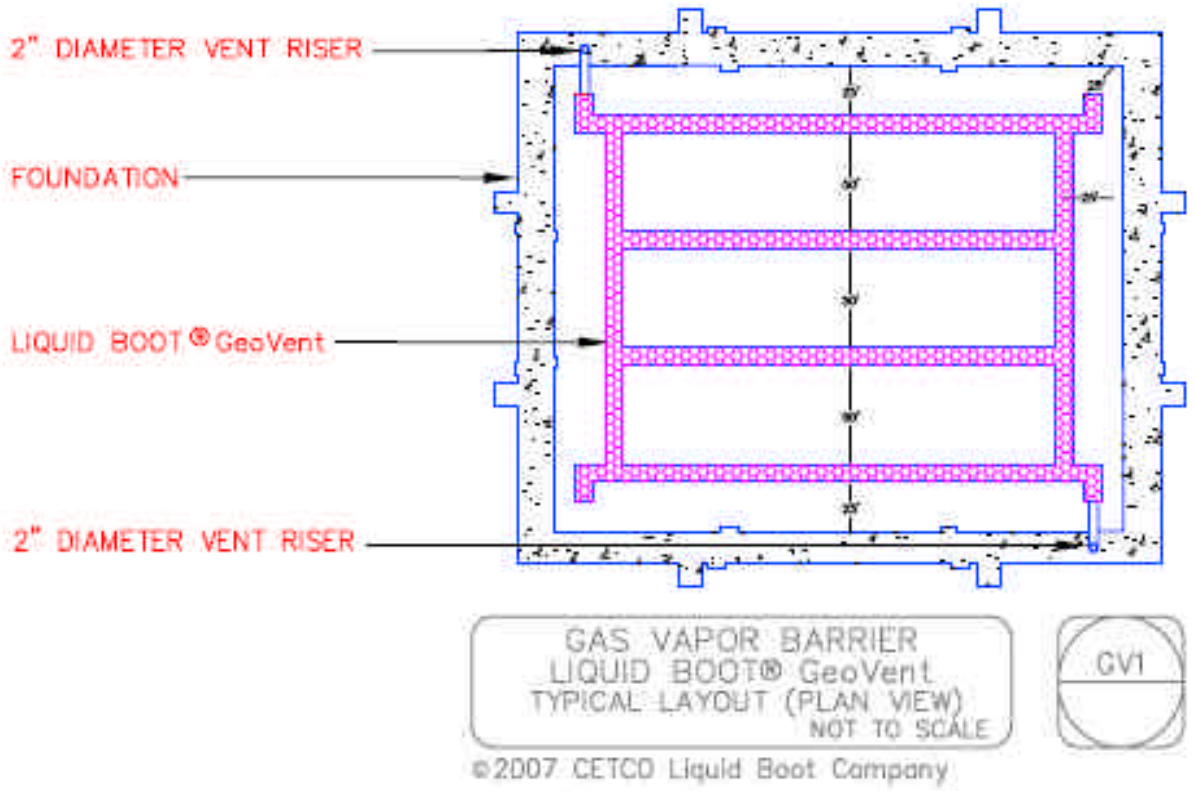
- Geogrids and geotextiles



Courtesy Liquid Boot®

Geosynthetic venting media

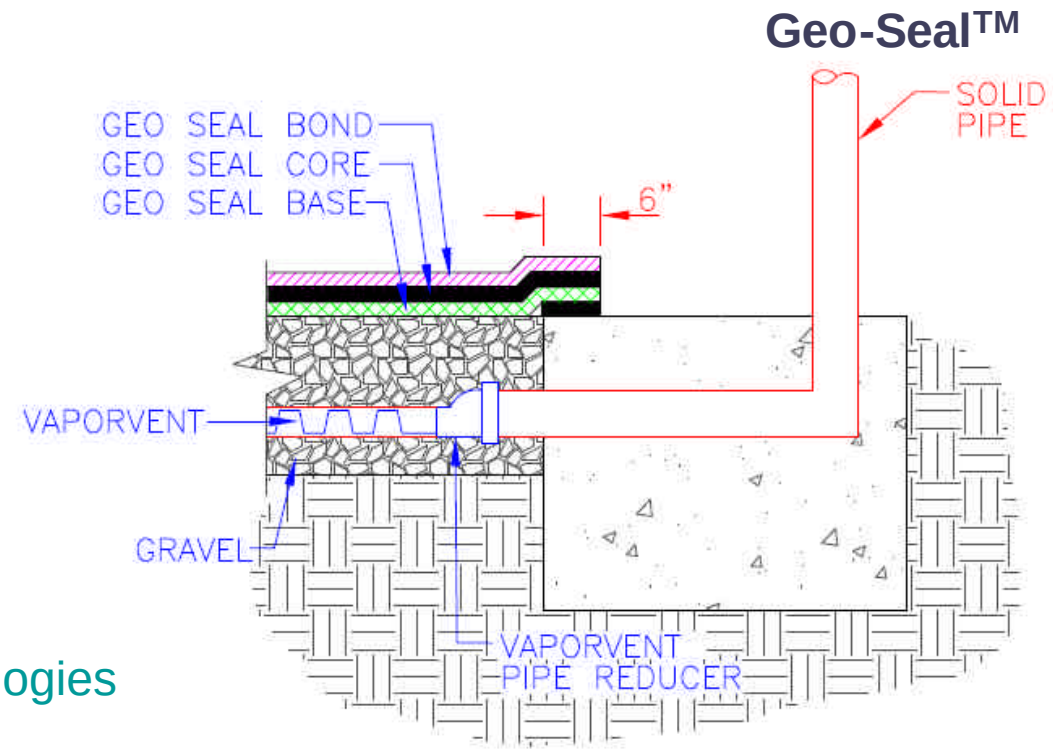
- Typically placed in strips



Courtesy Liquid Boot®

Geosynthetic venting media

- Vents typically placed in gravel



Courtesy Land Science Technologies

New Developments in SSD

- Basic “radon” system technology mature
- Generally very reliable if done well
- Works even when concentrations high
- Enhancements
  - Improved barriers (extend suction field)
  - Aerated floor systems (extend suction field)

Sustainable Mitigation

- The future - more emphasis on reduced energy requirements
  - Passive systems

Wind turbine

Solar-powered vents

Photos courtesy Pontarolo Engineering

Sustainable Mitigation

- The future - more emphasis on reduced energy requirements
  - Intermittent fan operation based on:
    - Pressure differential monitoring
    - Tied to operation of building exhaust fans
    - Tied to building occupancy
    - Real time concentration monitoring?

Information Resources

- www.envirogroup.com
  - Links to state and federal VI guidance
  - Download VI technical papers
  - Vapor Intrusion Newsletter (free)

- Questions?
  - dfolkes@envirogroup.com
  - 303-790-1340 ext. 111